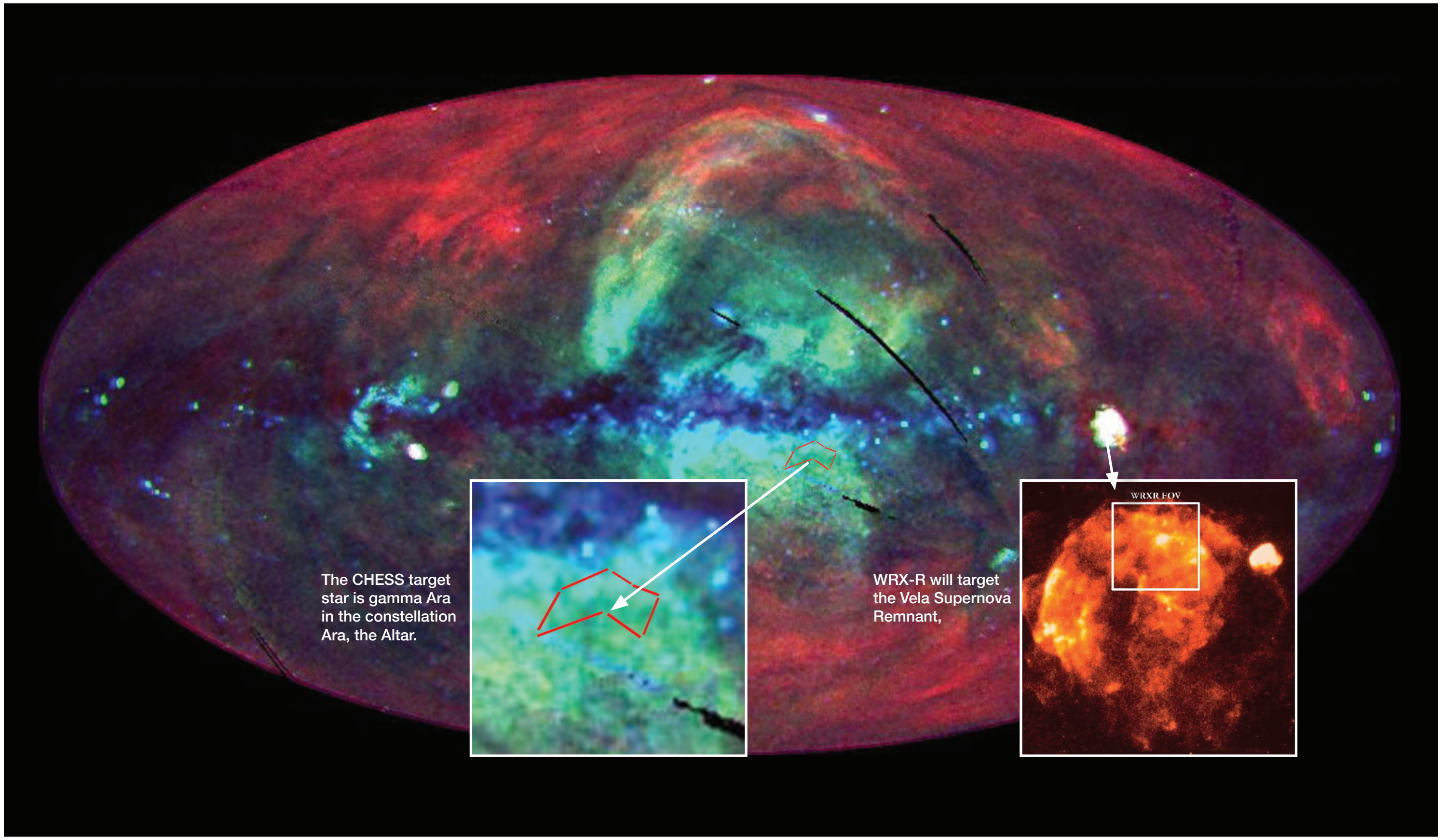
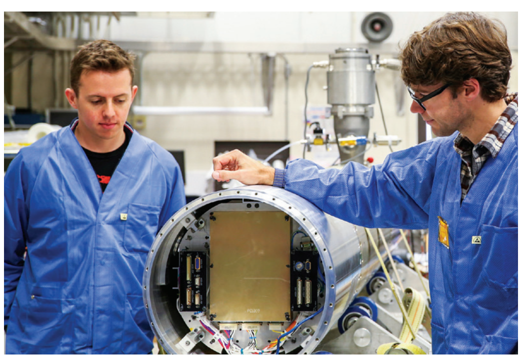
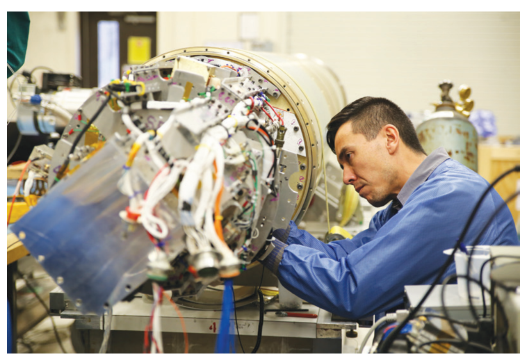
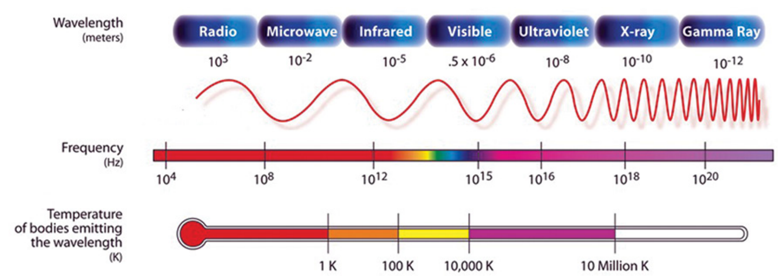
NASA Sounding Rockets study the beginning and end of the stellar life cycle









Electromagnetic Radiation

Two sounding rocket missions, the Water Recovery X-ray Rocket (WRX-R) and Colorado High-resolution Echelle Stellar Spectrograph (CHESS) 4, will be launched from Kwajalein, Marshall Islands, to study regions of the Milky Way where stars will be born and where they have died.

Spectra and Spectrometers

Astrophysics is a branch of research that seeks to understand the Universe and our place in it. It contributes to discoveries about how the Universe works, how it began, and evolved. Electromagnetic radiation is the only way to study these far-away places, and scientists use the entire spectrum, from high energy gamma rays to low energy radio waves to explore stars, galaxies, and everything in between. The two sounding rocket missions from Kwajalein will focus on Ultraviolet radiation and X-rays. Both missions use spectrometers to measure radiation intensity as a function of wavelength. The resulting spectra reveal composition and temperature of the object being studied. Each element in the periodic table exhibits a characteristic spectrum, with peaks at specific wavelengths. Atoms, consisting of a nucleus (protons and neutrons) and surrounded by a “cloud” of electrons, radiate energy when excited through photon absorption or collision with particles, such as electrons. The radiated energy is specific to the atom being energized. Two types of spectra, absorption and emission, are created depending on how an atom is excited. Absorption spectra are created when energy from a hot opaque object travels through cooler transparent gas, while hot transparent gas, such as Supernova Remnants, create emission spectra.

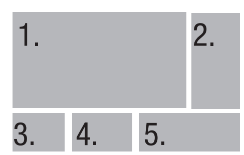
The WRX-R mission targets the Vela Supernova Remnant (SNR) and measures soft X-rays emanating from this region. The Vela SNR was created when a star, >10 times the mass of the Sun, collapsed and then exploded as a Supernova, the final stage of stellar evolution. Supernova explosions are one of the most energetic events in the Universe, and play a role in recycling material within galaxies. They are responsible for the creation and distribution of elements such as, oxygen, silicon, neon, iron, nickel, and magnesium among others, into the interstellar medium, thereby providing source material for the next generation of stars, planets, and even organic chemistry. The explosions are rarely seen in action, but evidence is left behind as Supernova Remnants. Ejected material from the explosion travels at high speeds and the shockwave sweeps up interstellar material along the way, continuing to heat it to temperatures as high as 10 million Kelvin. Hotter temperatures lead to the emission of higher energy electromagnetic radiation, such as X-rays, from the SNR.

WRX-R measures soft X-rays with an energy range of 0.25 - 0.8 kilo electron Volts (keV), focusing on emission lines for ions of Oxygen^{6+}, i.e. Oxygen lacking six of its eight electrons, O^{7+} (seven of eight electrons missing) and Carbon^{5+} (five of six electrons missing). The data will show how much of each constituent is present, and allow scientists to derive information about the conditions in the Vela SNR such as the temperature, density, chemical composition, and ionization state. Using these characteristics they will also be able to estimate the shock velocity near the SNR limb, the age and type of the SNR, the energy of the supernova, and the mass of the progenitor.

The CHESS-4 mission will study the interstellar medium (ISM), the matter between stars, and specifically translucent clouds of gas which provide fundamental building blocks for star and planet formation. These clouds have very low densities and the only way to study them is to measure absorption spectra of light from stars passing through the cloud. The CHESS spectrograph measures energies in the Far-Ultraviolet part of the spectrum, 1000 - 1600 Ångstrom. This covers wavelengths of, for example, Oxygen^{5+}, H2, several levels of ionized Carbon, Fe II and Mg II (once ionized Iron and Magnesium). The gas in the cloud absorbs some of the wavelengths of light from the star, leading to dark bands in the spectrum. For example, molecular hydrogen (H2) has a system of absorption lines near 1100 Å (110 nm). H2 traces cool molecular material (100 Kelvin), and makes up 99.99% of the total molecular gas in the Galaxy. If H2 is present in the cloud that the starlight passes through, the spectrograph will show less energy at wavelengths near 1100 Å.

CHESS will be pointed at the star Gamma Ara, in the constellation Ara. Gamma Ara displays an unusually powerful stellar wind; CHESS will study the interaction of this stellar wind with the surrounding ISM to study the excitation of atoms and molecules in the interface region. This allows the CHESS team to study the catalysts of Galactic chemistry and the raw materials for future generations of stars and planets, as well as, quantify the temperature and motions of the clouds along the line of sight.

ABOUT THE IMAGES



1. Soft X-ray sky from ROSAT.
2. Terrier-Black Brant sounding rockets with WRX-R and CHESS payloads.
3. CHESS payload during integration at NASA GSFC Wallops Flight Facility
4. WRX-R payload during integration at NASA GSFC Wallops Flight Facility
5. Electromagnetic Spectrum